



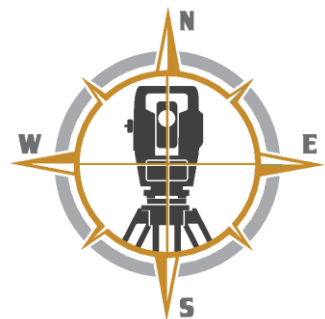
جامعة الأمير مقرن بن عبد العزيز
University of Prince Mugrin

AE 475 - Surveying



Week . 7

ANGLES AND DIRECTIONS 2

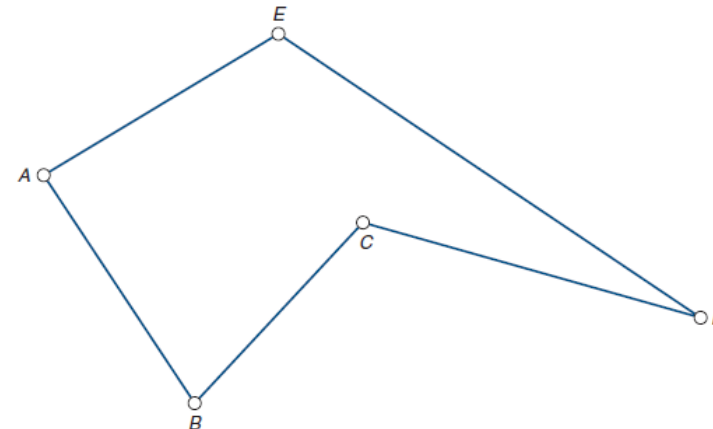
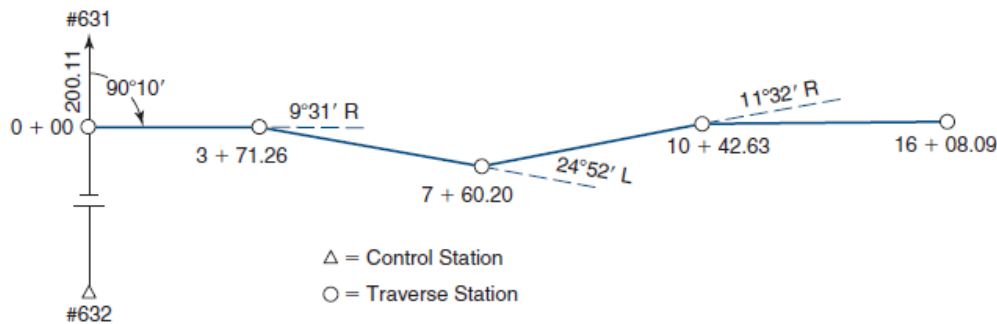


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Traverse

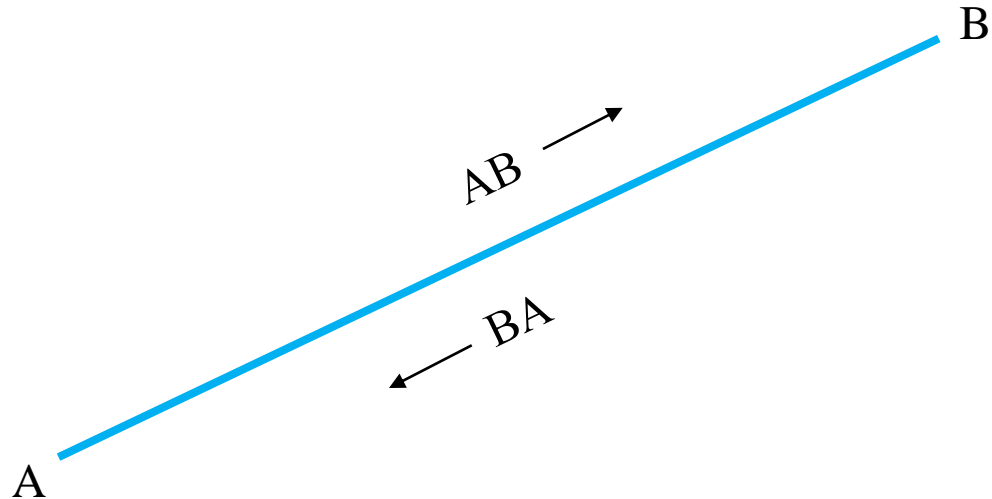
- **Traverse** is a method in the field of surveying to establish **control networks**
- Traverses are a series of established stations that are tied together by **angle** and **distance**.
- The **angles** are measured using **theodolites**, or **total stations**, whereas the **distances** can be measured using **total stations**, electronic distance measurement (**EDM**) instruments, or **steel tapes**.
- Traverses can be **open**, or **closed**



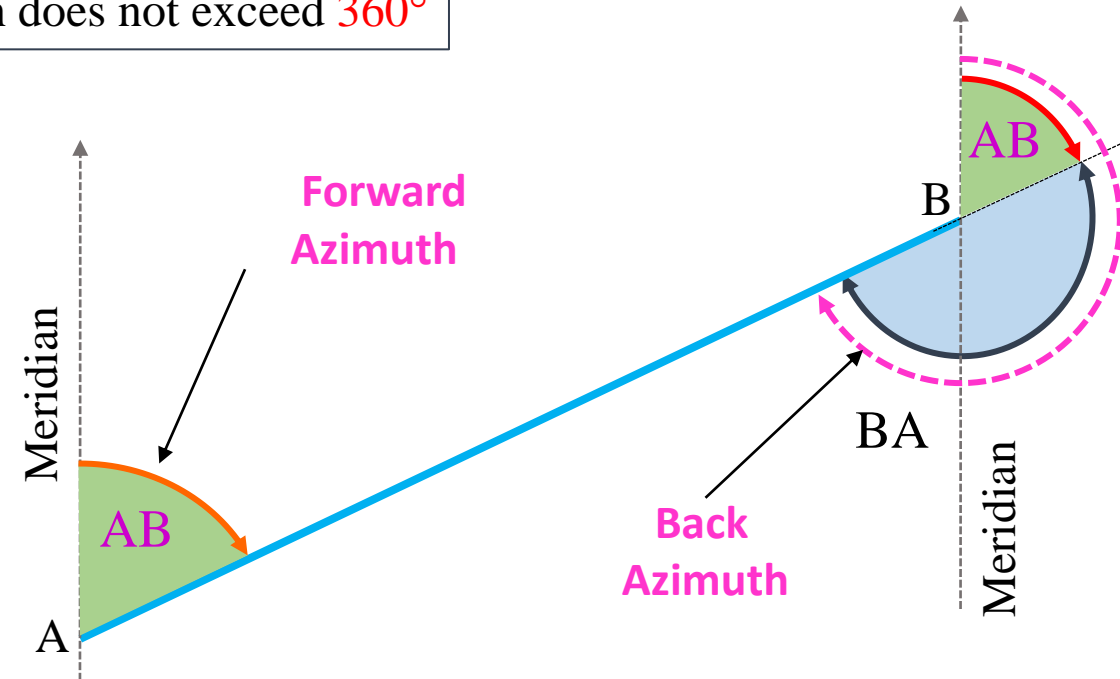
Reverse Directions

In surveying, a direction is called *forward* if it is oriented in the direction of fieldwork or computation staging. If the direction is the reverse of that, it is called a *back direction*.

The *back azimuth* of a line is determined simply by adding (or subtracting) 180° to the forward azimuth; when the forward azimuth is more than 180° , 180° is subtracted so that the numerical value of the back azimuth does not exceed 360°



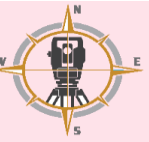
\overrightarrow{AB} = *forward* directions
 \overleftarrow{BA} = *back* directions



Back direction = Forward direction ± 180

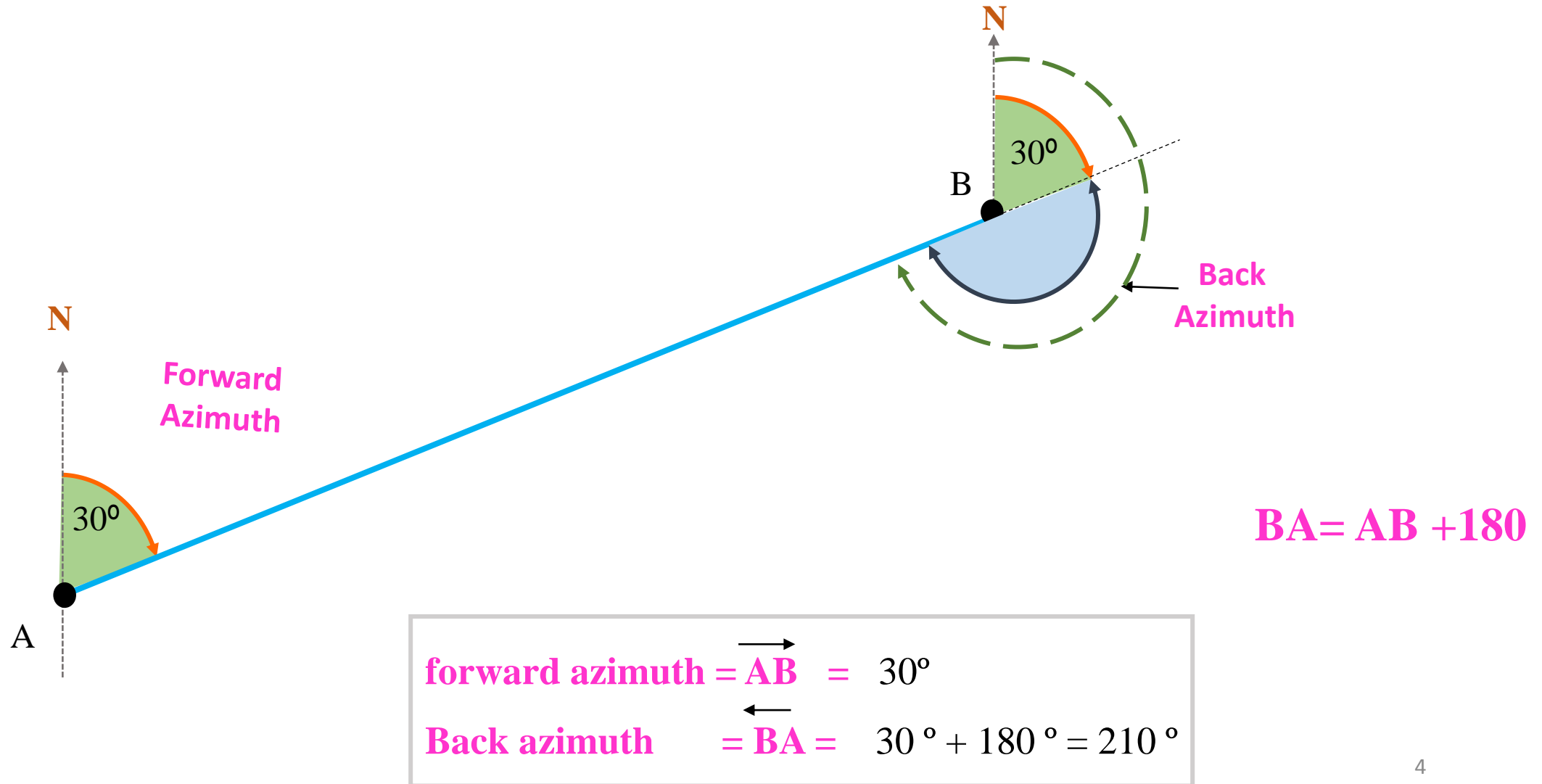


Directions of A Line

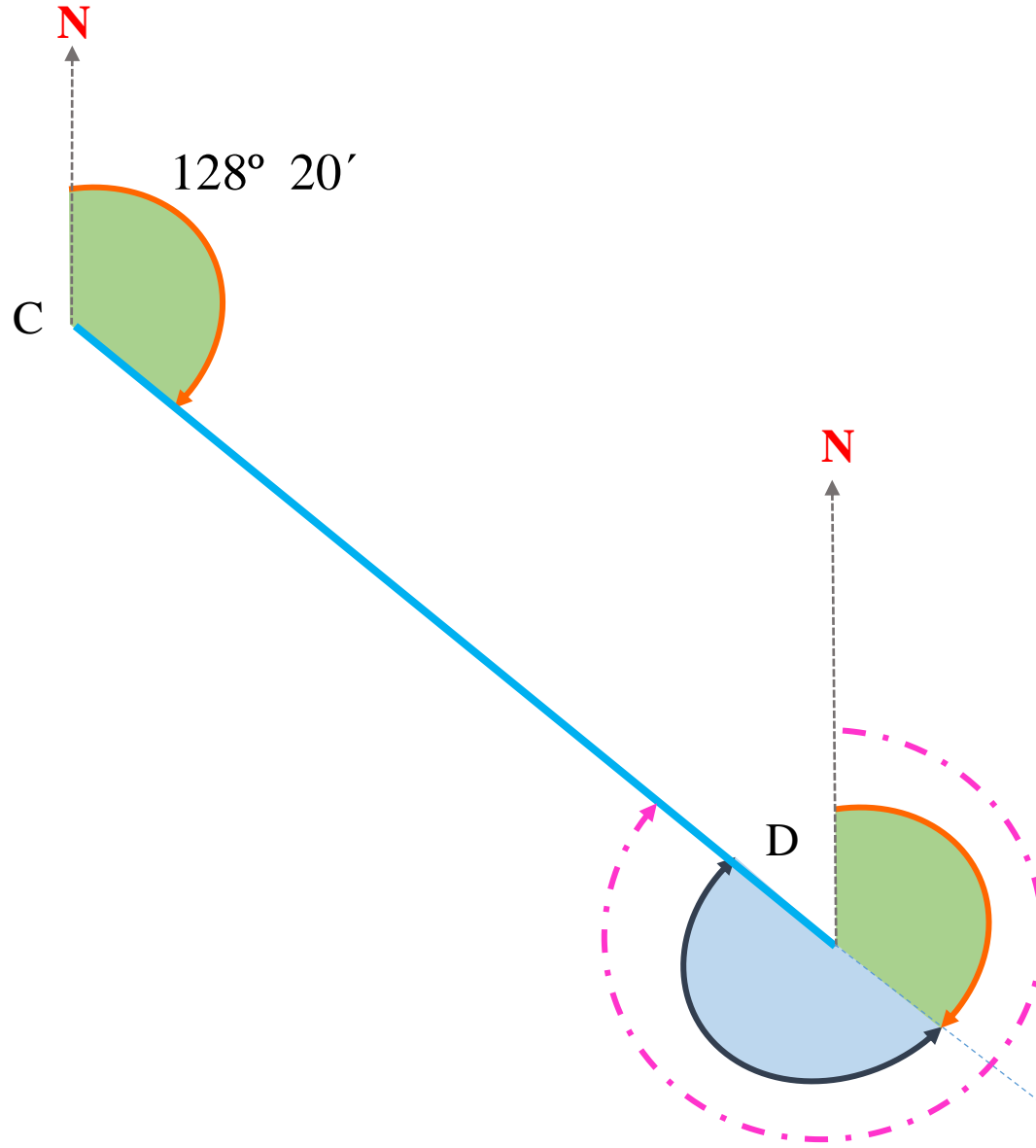


Every line has two directions that differ by 180° namely: the **forward azimuth** and the **back azimuth**.

Example (1):



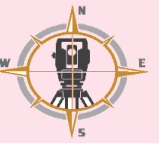
Example (2):



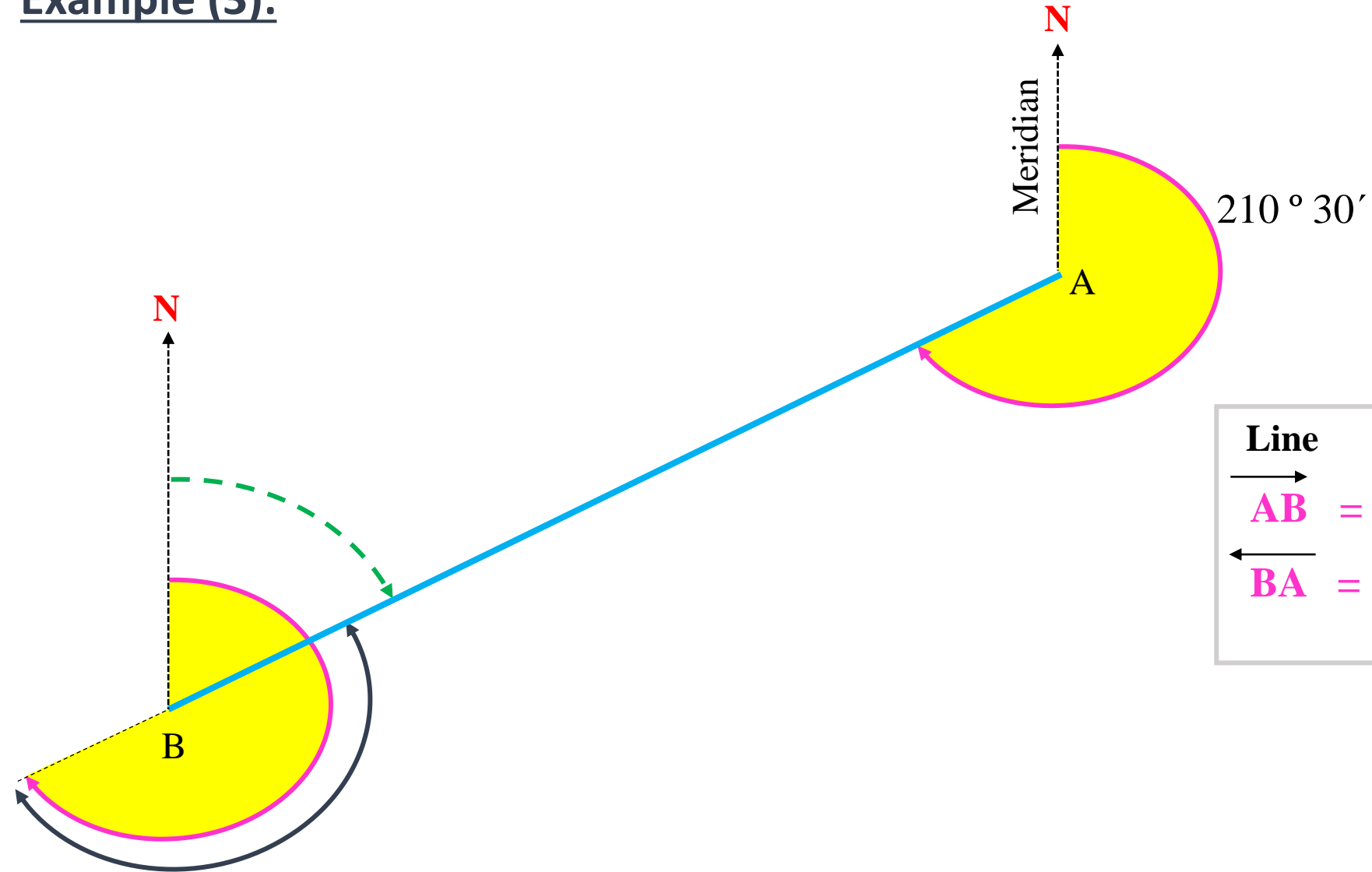
Line	Azimuth
\overrightarrow{CD}	$= 128^{\circ} 20'$
\overleftarrow{DC}	$= 128^{\circ} 20' + 180^{\circ} = 308^{\circ} 20'$



Directions of A Line



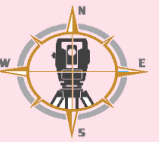
Example (3):



Line	Azimuth
\overrightarrow{AB}	$= 210^\circ 30'$
\overleftarrow{BA}	$= 210^\circ 30' - 180^\circ = 30^\circ 30'$

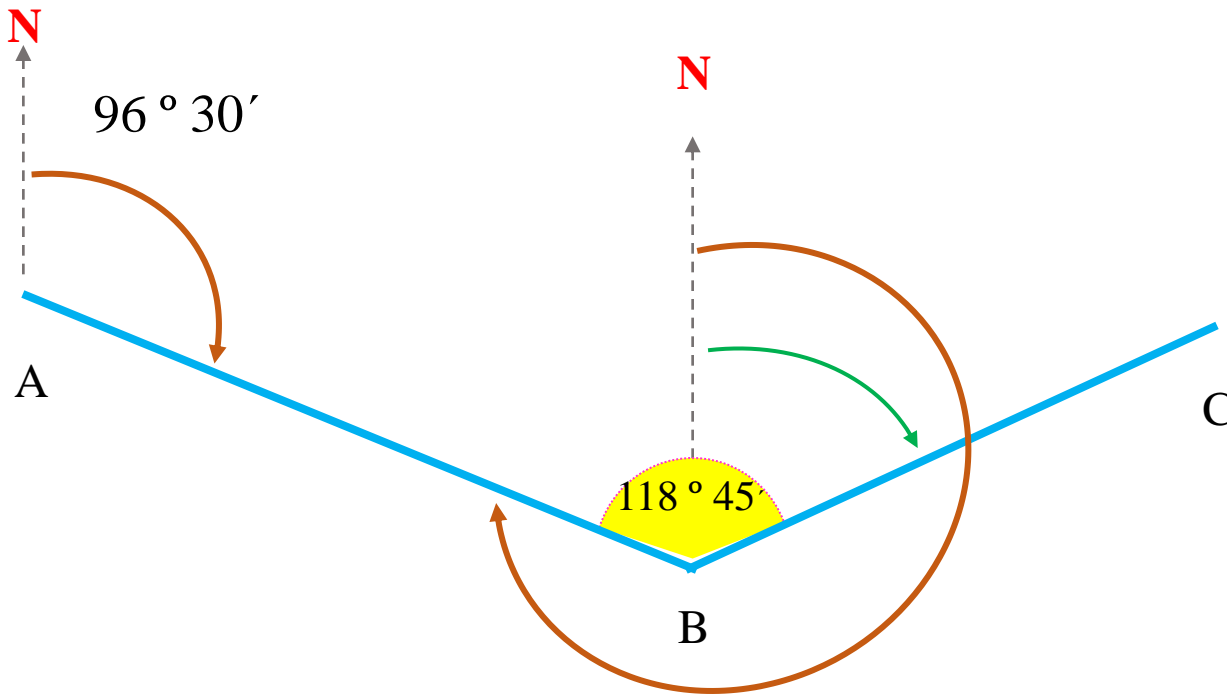


Azimuth of a line



How to determine an azimuth of a line BC if the following are given:

- 1- Azimuth of line AB (θ_{AB})
- 2- Clockwise angle between line AB and Line BC (α)



$$AB = 96^{\circ} 30'$$

$$BA = AB + 180$$

$$BA = 96^{\circ} 30' + 180^{\circ} 00' = 276^{\circ} 30'$$

$$BC = 276^{\circ} 30' - (360^{\circ} - 118^{\circ} 45')$$

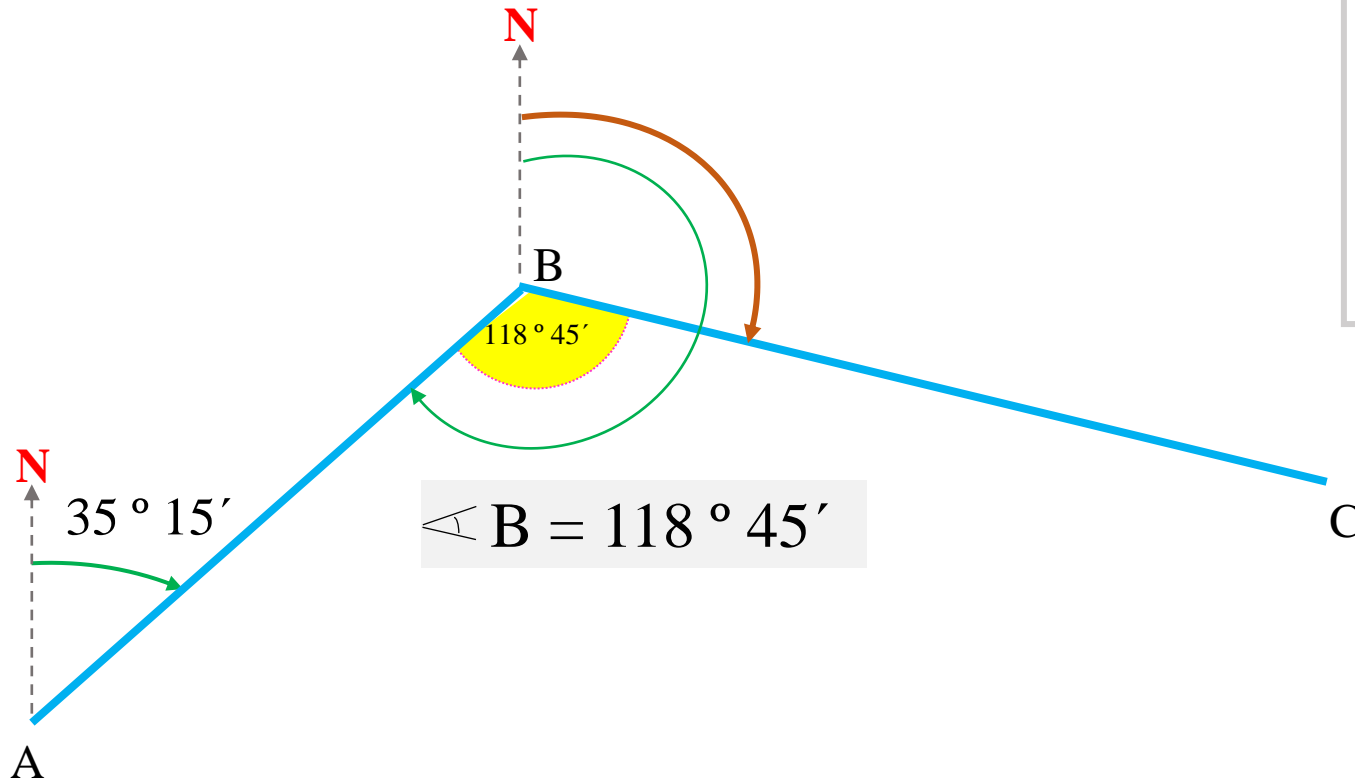
$$BC = 35^{\circ} 15'$$

Note: The computation is proceeding in a *counterclockwise* direction

Azimuth of a line

How to determine an azimuth of a line BC if the following are given:

- 1- Azimuth of line AB (θ_{AB})
- 2- Clockwise angle between line AB and Line BC (α)



Line	Azimuth
$AB = 35^\circ 15'$	
$BA = AB + 180$	
$BA = 35^\circ 15' + 180^\circ 00' = 215^\circ 15'$	
$BC = BA - \angle B$	
$BC = 215^\circ 15' - 118^\circ 45' = 96^\circ 30'$	

$$AB = 35^\circ 15'$$

$$BA = AB + 180$$

$$BA = 35^\circ 15' + 180^\circ 00' = 215^\circ 15'$$

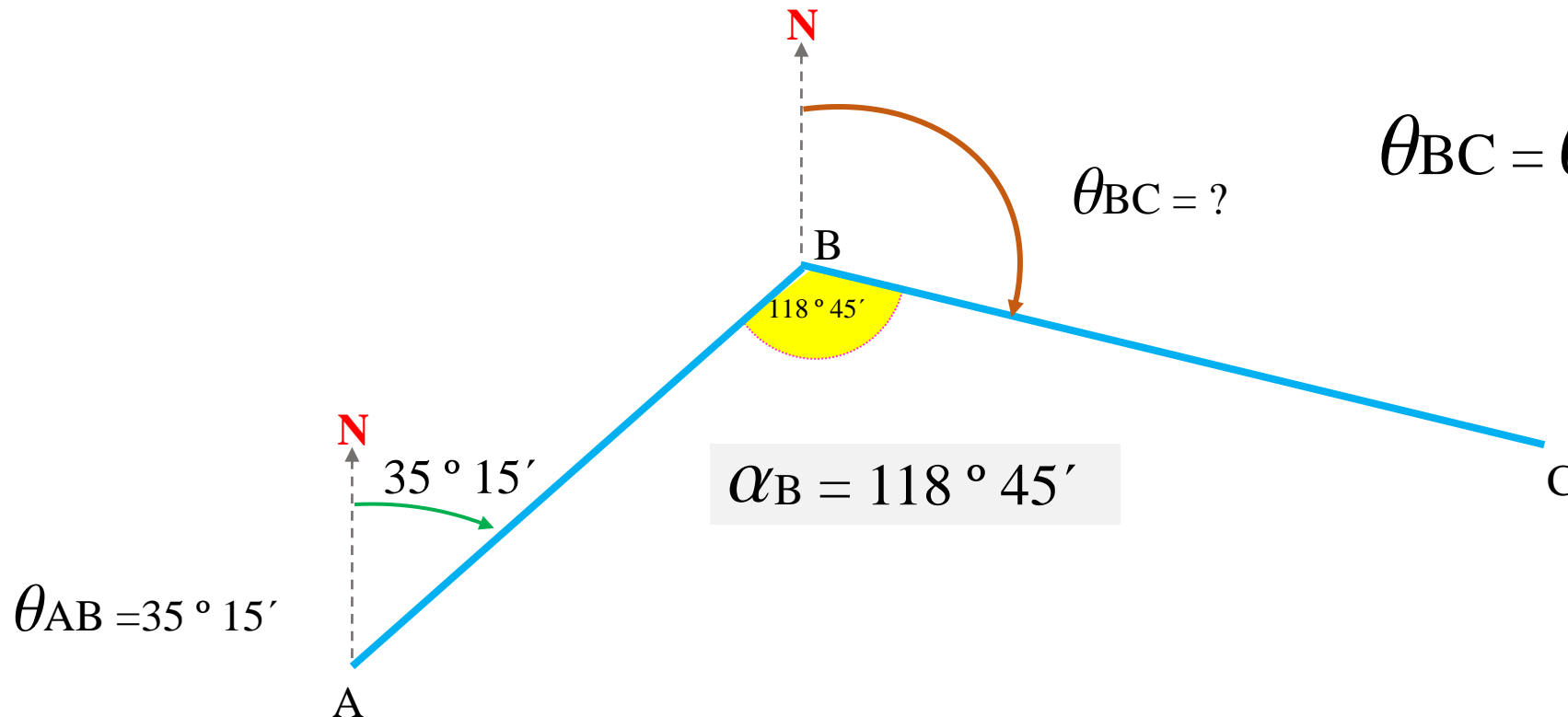
$$BC = BA - \angle B$$

$$BC = 215^\circ 15' - 118^\circ 45' = 96^\circ 30'$$

Note: The computation is proceeding in a *clockwise* direction

How to determine an azimuth of a line BC if the following are given:

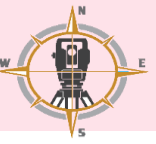
- 1- Azimuth of line AB (θ_{AB})
- 2- Clockwise angle between line AB and Line BC (α)



$$\theta_{BC} = \theta_{AB} + \alpha_B \pm 180^\circ$$



Azimuth of a line



$$\theta_{BC} = \theta_{AB} + \alpha_B \pm 180^\circ$$

$(\theta_{AB}) \equiv$ Azimuth of line AB

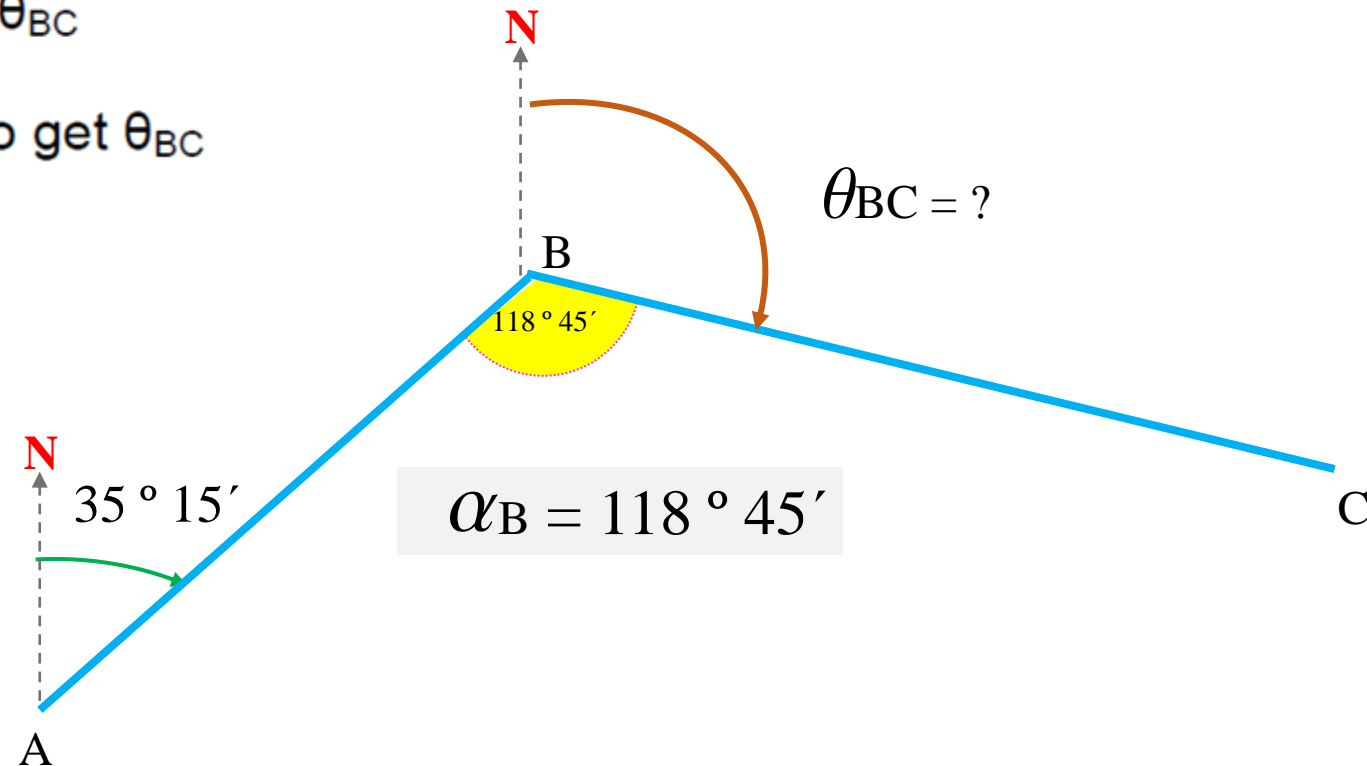
$\alpha_B \equiv$ Clockwise angle between line AB and Line BC

if $\theta_{AB} + \alpha < 180^\circ \Rightarrow$ add 180° to get θ_{BC}

if $\theta_{AB} + \alpha > 180^\circ \Rightarrow$ subtract 180° to get θ_{BC}

$$\begin{aligned}\theta_{BC} &= 35^\circ 15' + (360^\circ - 118^\circ 45') \\ &- 180^\circ = 96^\circ 30'\end{aligned}$$

$$\theta_{AB} = 35^\circ 15'$$



Note: The computation is proceeding in a *clockwise* direction

$$\theta_{BC} = \theta_{AB} + \alpha_B \pm 180^\circ$$

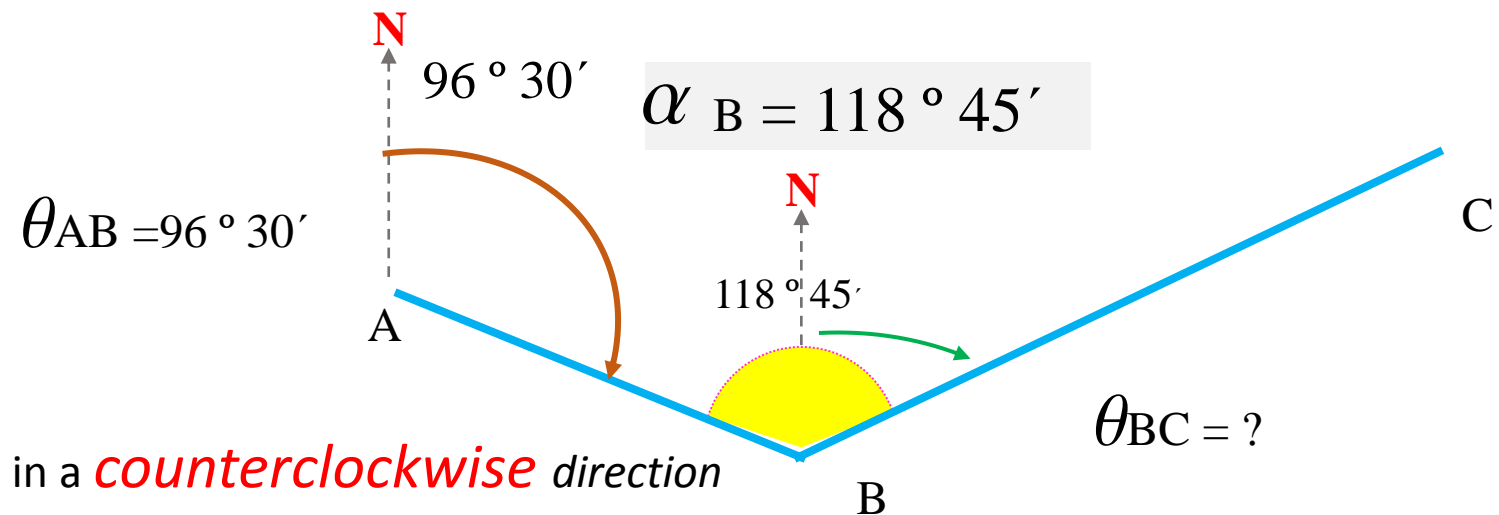
$(\theta_{AB}) \equiv$ Azimuth of line AB

$\alpha_B \equiv$ Clockwise angle between line AB and Line BC

if $\theta_{AB} + \alpha < 180^\circ \Rightarrow$ add 180° to get θ_{BC}

if $\theta_{AB} + \alpha > 180^\circ \Rightarrow$ subtract 180° to get θ_{BC}

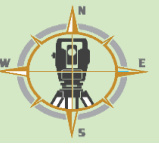
$$\theta_{BC} = 96^\circ 30' + 118^\circ 45' - 180^\circ = 35^\circ 15'$$



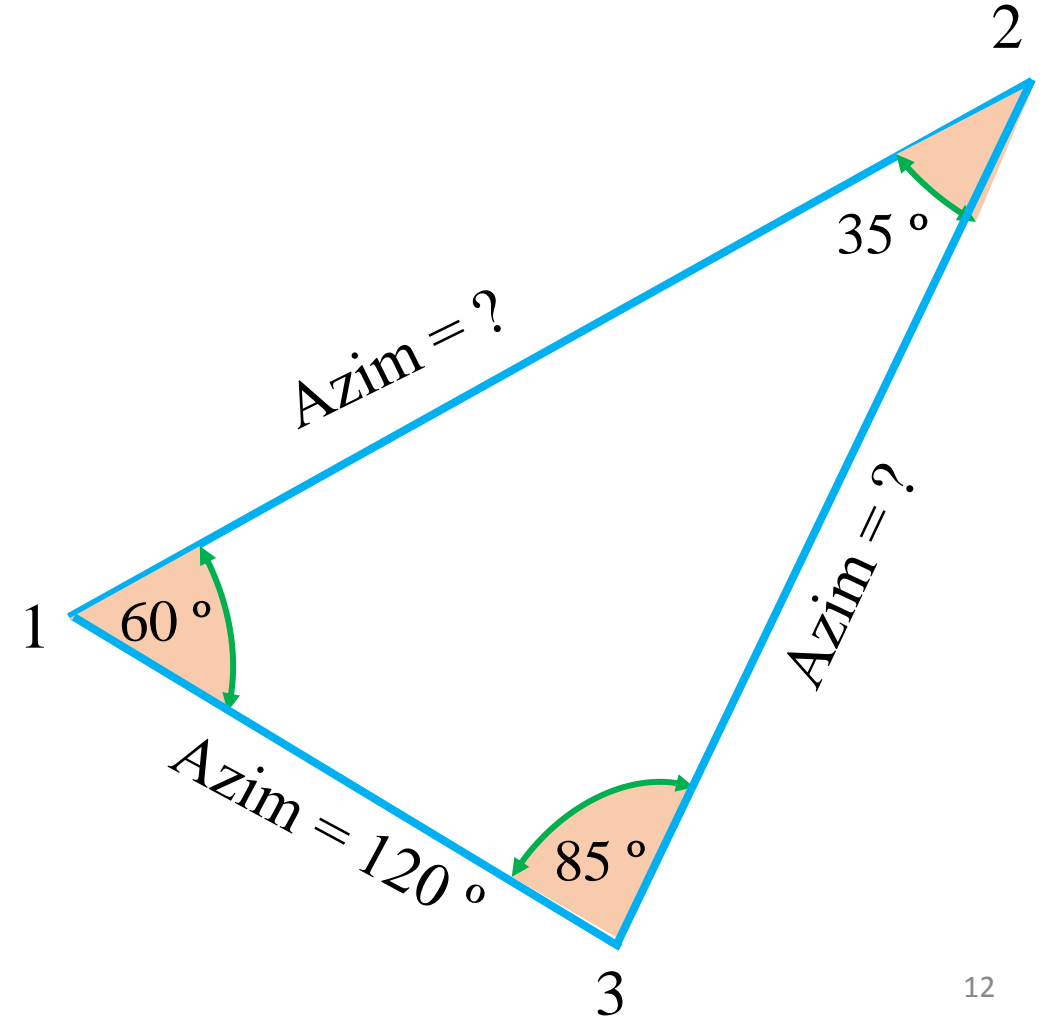
Note: The computation is proceeding in a *counterclockwise* direction



Example (4)

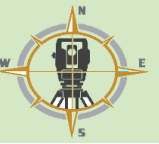


The azimuth of side **1–3** is given for the three-sided traverse shown in the following figure. The three interior angles are also given. Determine the **azimuth direction** for the other sides.

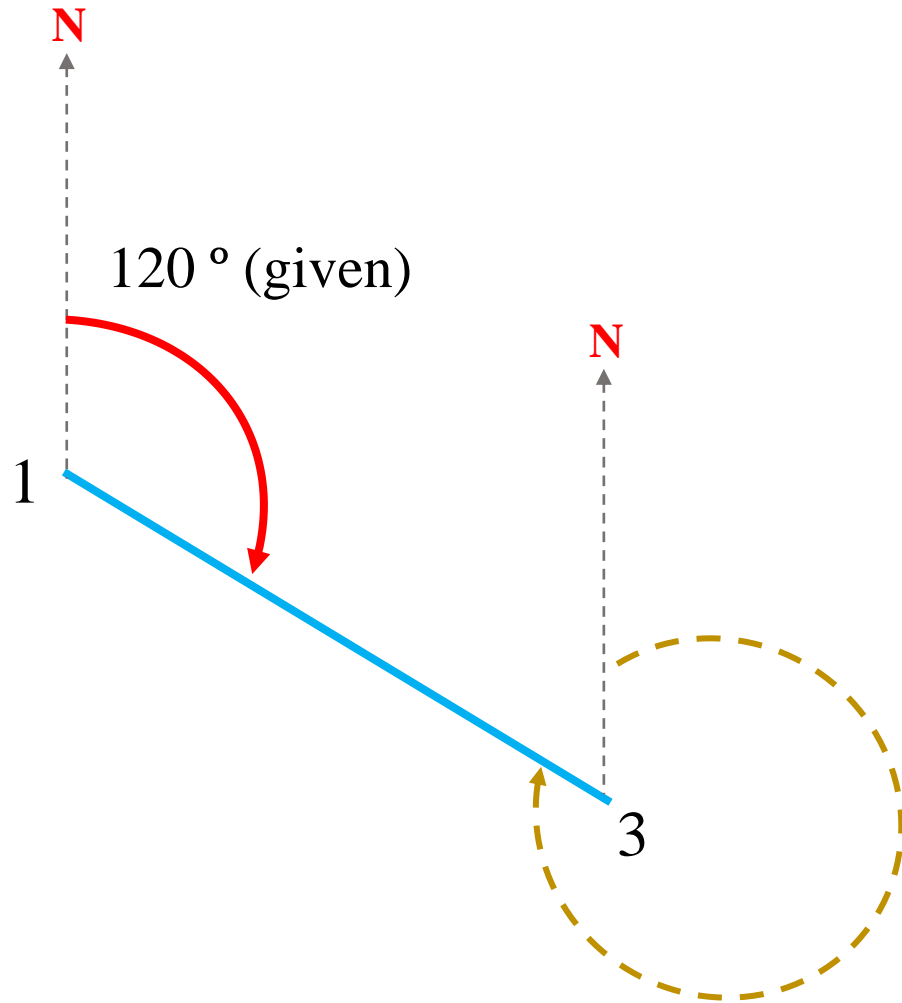




Example (4)



Step 1 :

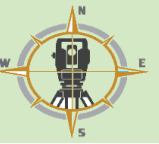


$$\text{Azimuth 1-3} = \theta_{1-3}$$

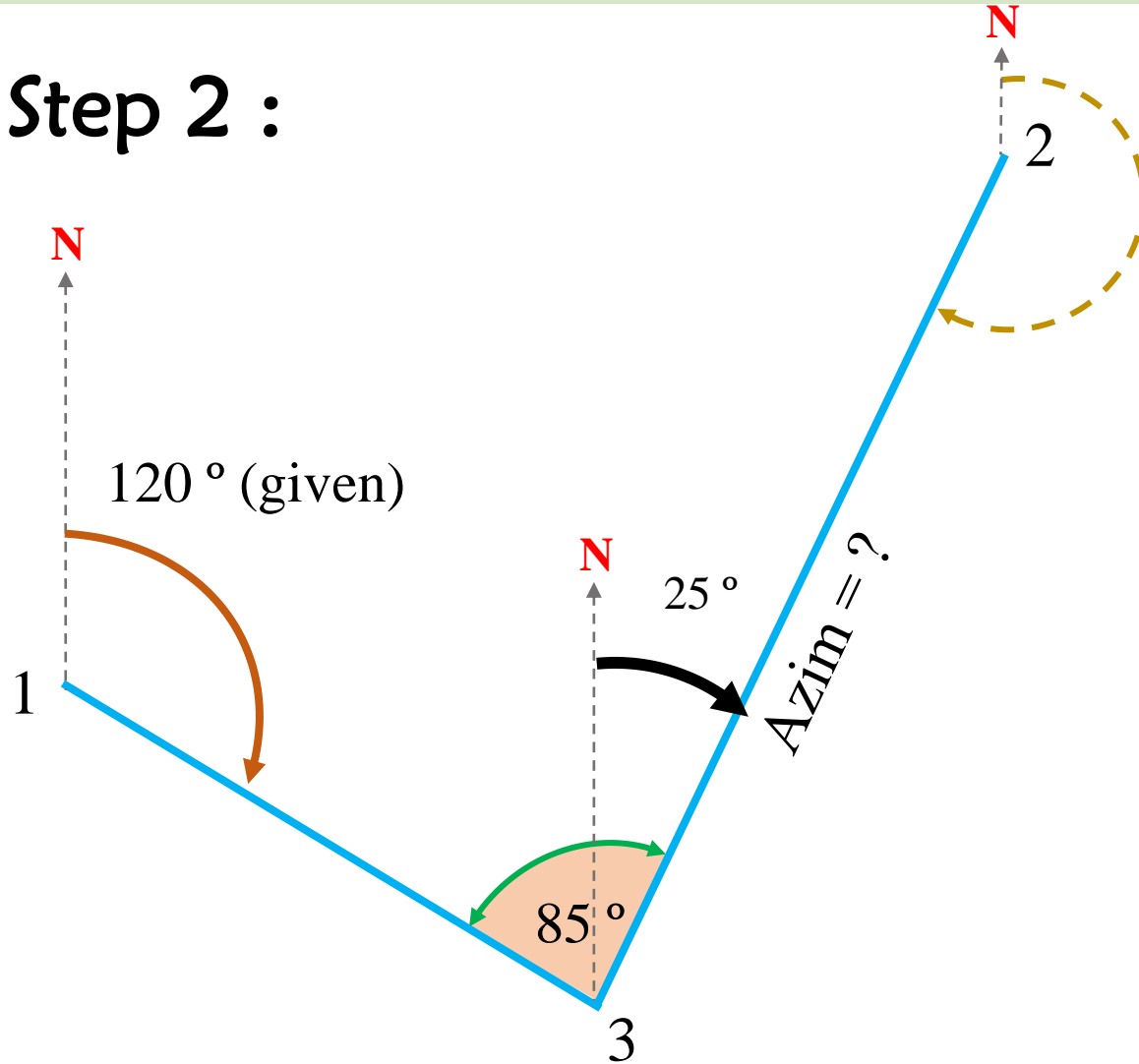
$$\theta_{1-3} = 120^\circ \text{ (given)}$$

$$\begin{aligned} \text{Azimuth 3-1} &= 120^\circ + 180^\circ \\ &= 300^\circ \end{aligned}$$

Example (4)



Step 2 :

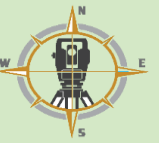


$$\text{Azimuth } 3-2 = \theta_{3-2}$$

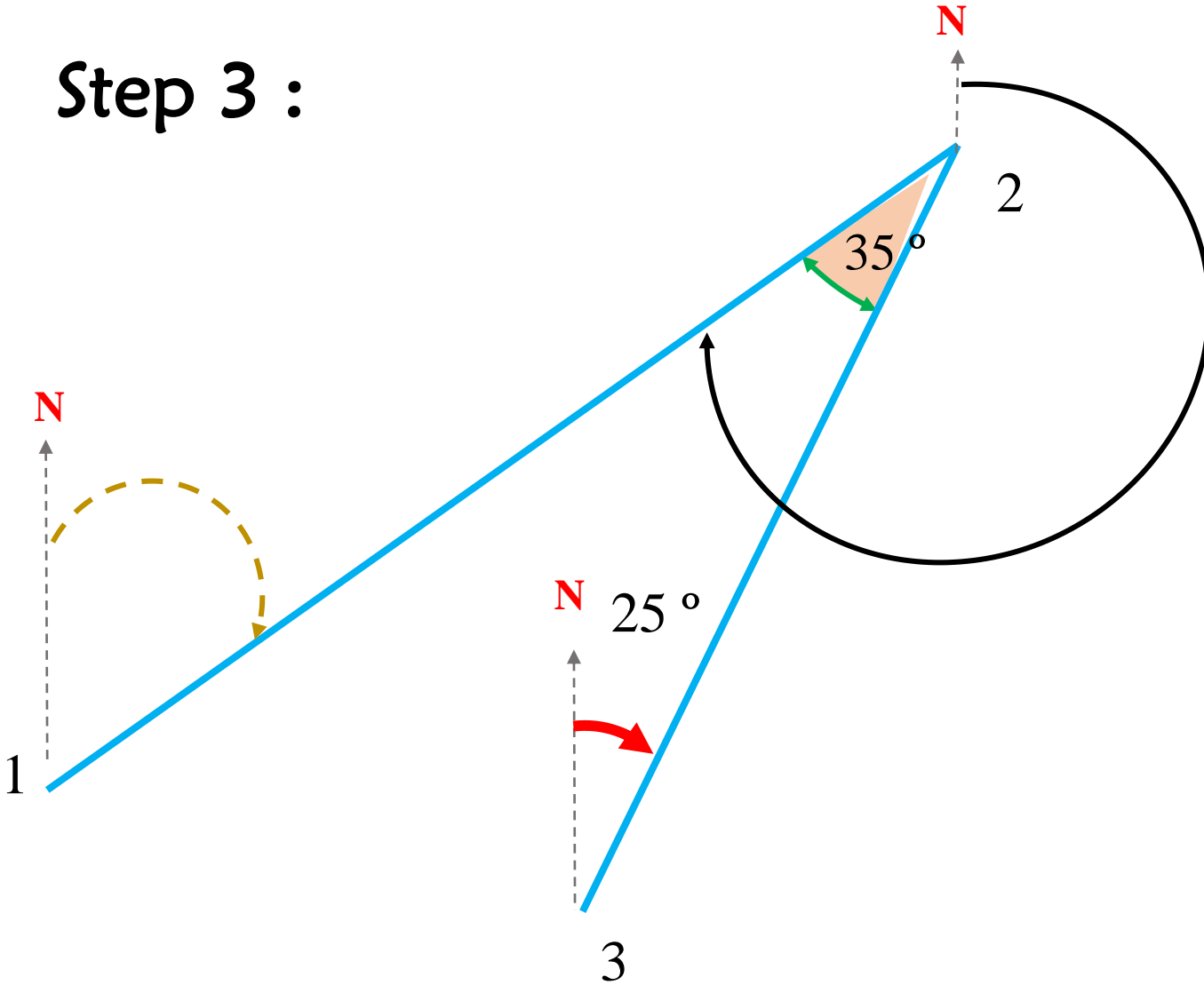
$$\begin{aligned} \theta_{3-2} &= 120^\circ + 85^\circ - 180^\circ \\ &= 25^\circ \end{aligned}$$

$$\begin{aligned} \text{Azimuth } 2-3 &= 25^\circ + 180^\circ \\ &= 205^\circ \end{aligned}$$

Example (4)



Step 3 :



$$\text{Azimuth } 2-1 = \theta_{2-1}$$

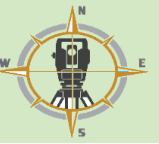
$$\theta_{2-1} = 25^\circ + 35^\circ + 180^\circ = 240^\circ$$

$$= 240^\circ$$

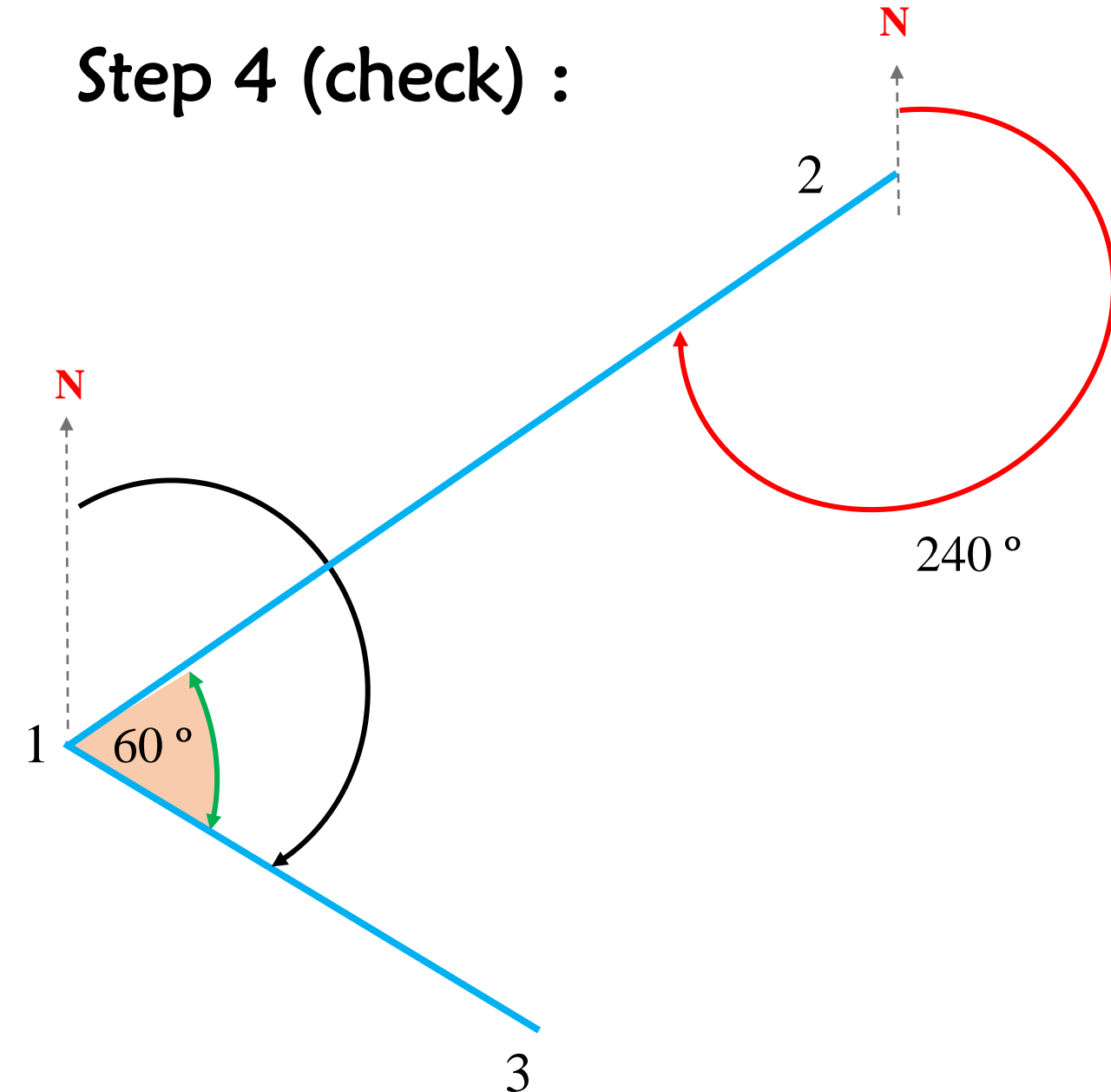
$$\text{Azimuth } 1-2 = 240^\circ - 180^\circ$$

$$= 60^\circ$$

Example (4)



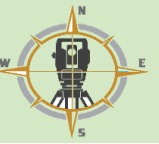
Step 4 (check) :



$$\text{Azimuth 1-3} = \theta_{1-3}$$

$$\begin{aligned} \theta_{1-3} &= 240^\circ + 60^\circ - 180^\circ \\ &= 120^\circ \text{ (the same as the given)} \end{aligned}$$

Example (4)



$$\text{Azimuth } 1-2 = 60^\circ$$

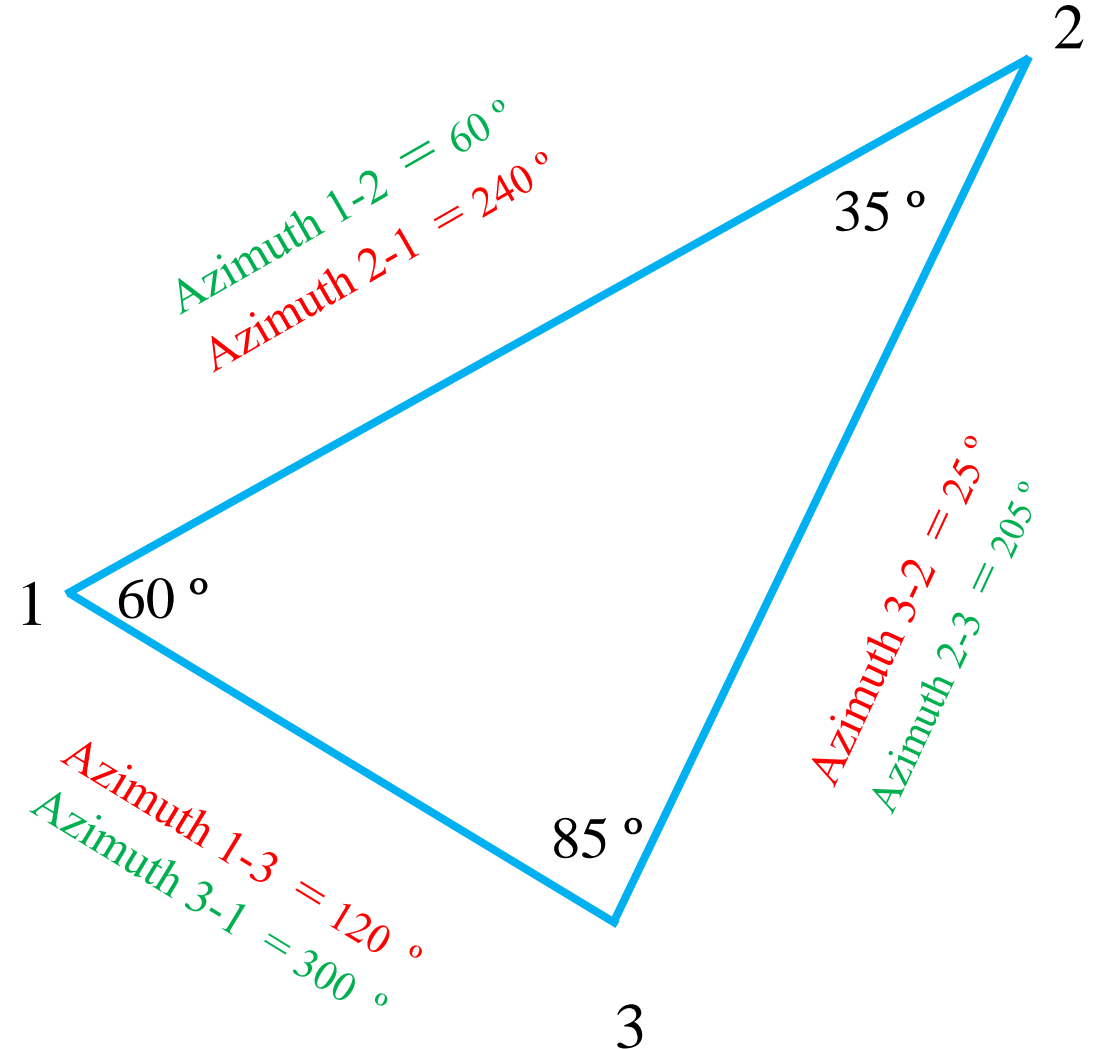
$$\text{Azimuth } 2-1 = 240^\circ$$

$$\text{Azimuth } 1-3 = 120^\circ$$

$$\text{Azimuth } 3-1 = 300^\circ$$

$$\text{Azimuth } 2-3 = 205^\circ$$

$$\text{Azimuth } 3-2 = 25^\circ$$

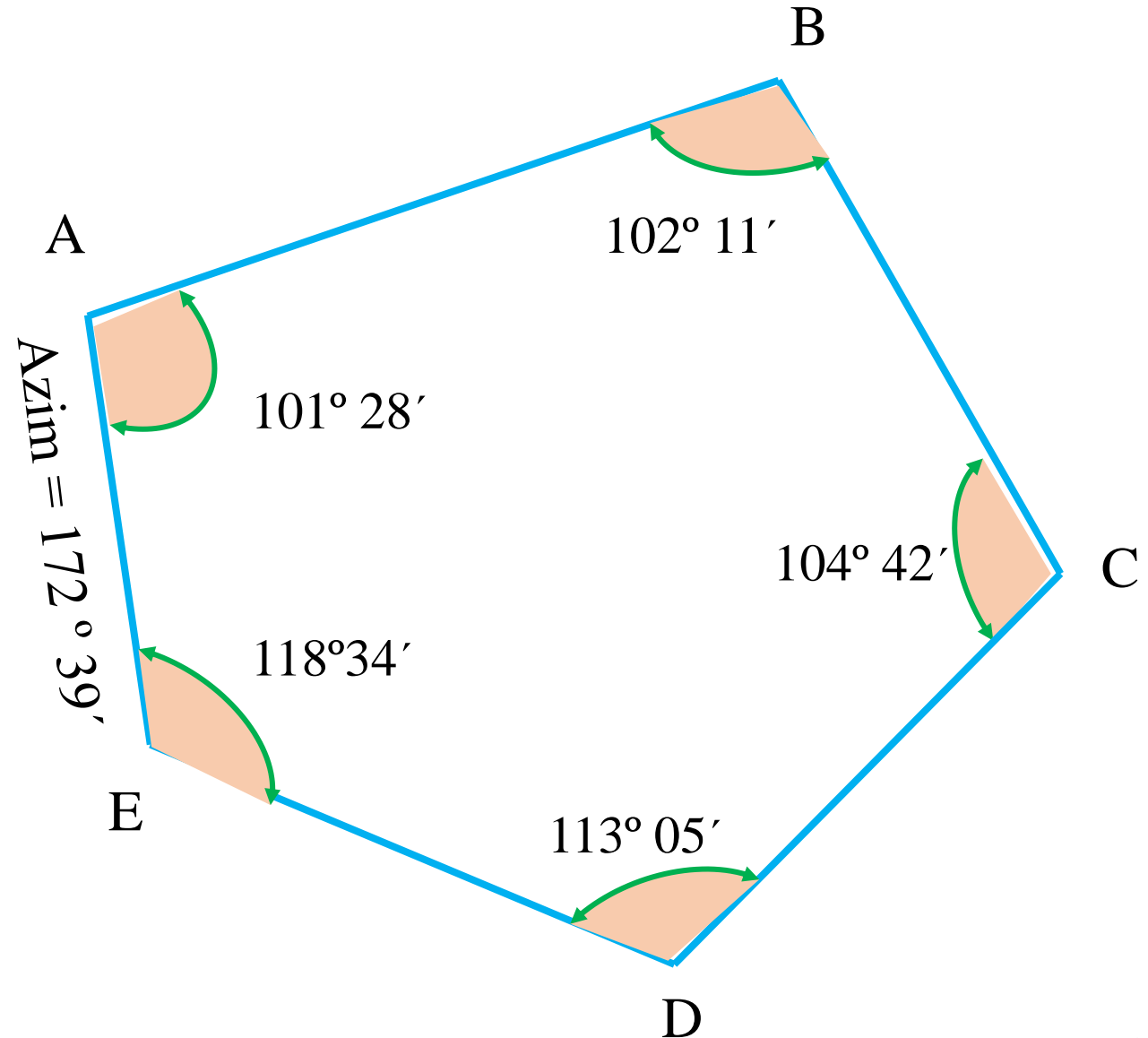




Example (5)

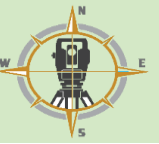


The azimuth of side **A–E** is given for the five-sided traverse shown in the following figure. The five interior angles are also given. Determine the **azimuth direction** for the other sides.

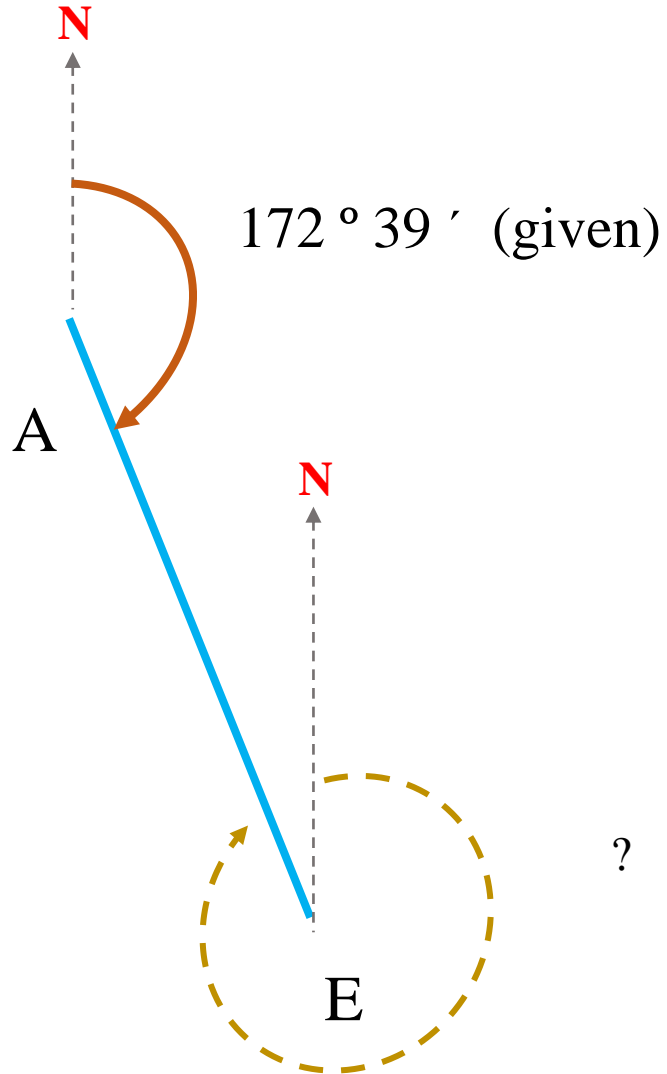




Example (5)



Step 1 :

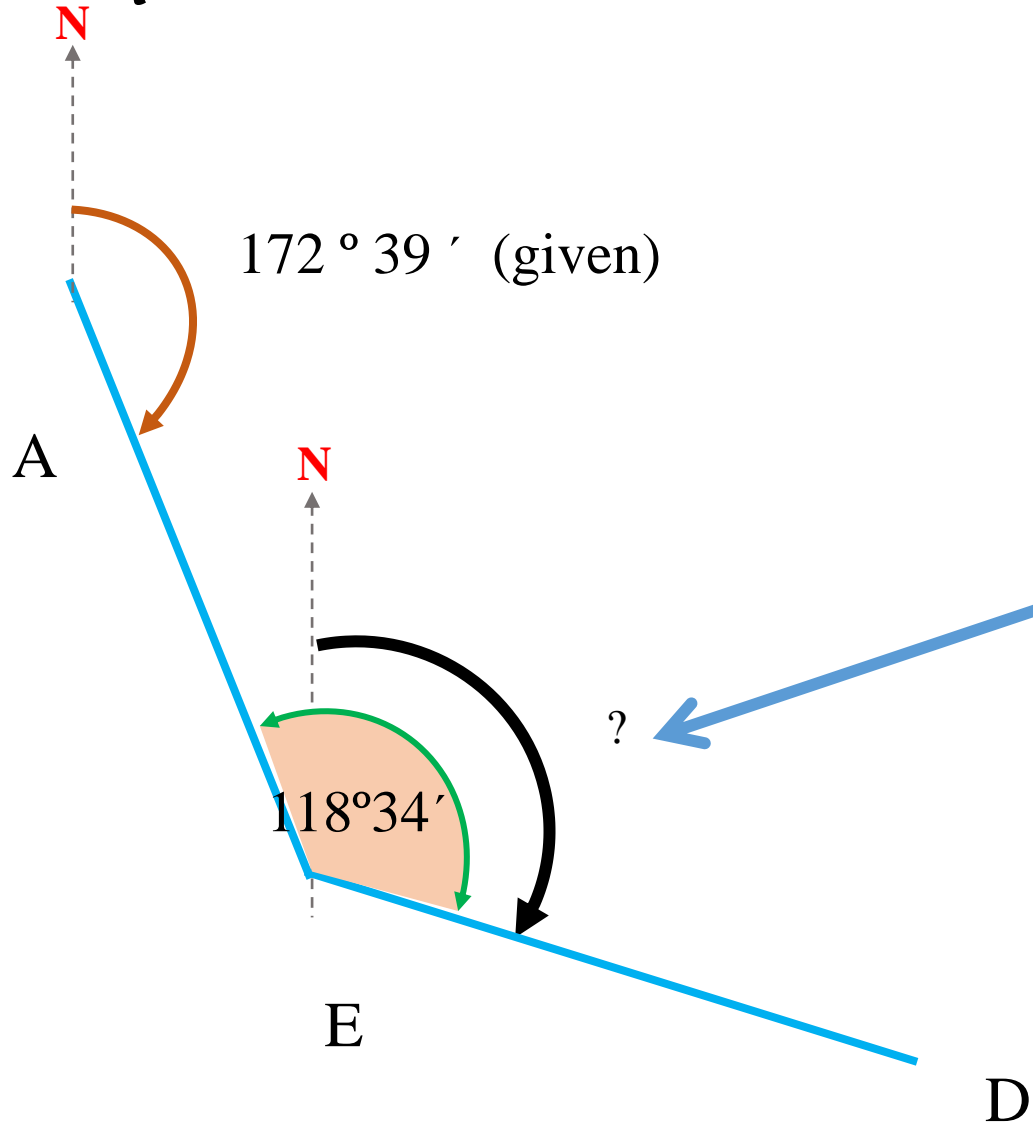


$$\text{Azimuth A-E} = \theta_{\text{A-E}}$$

$$\theta_{\text{A-E}} = 172^{\circ} 39' \text{ (given)}$$

$$\begin{aligned} \text{Azimuth E-A} &= 172^{\circ} 39' + 180^{\circ} \\ &= 352^{\circ} 39' \end{aligned}$$

Step 2 :

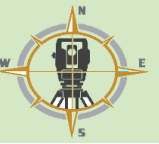


$$\theta_{A-E} = 172^\circ 39' \text{ (given)}$$

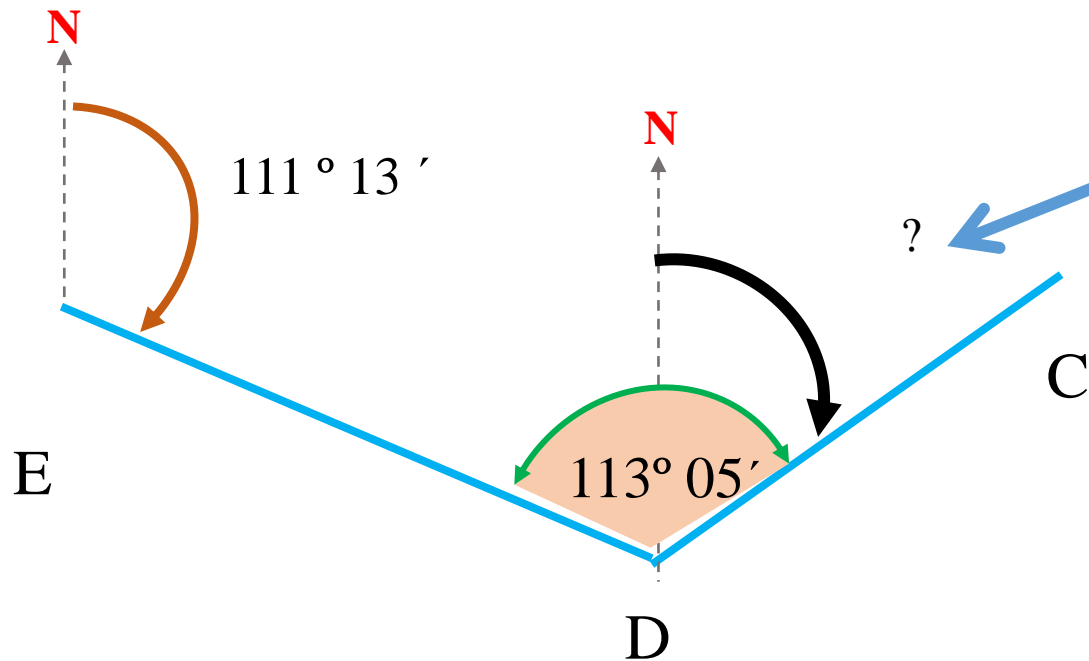
$$\begin{aligned} \text{Azimuth E-D} &= 172^\circ 39' + 118^\circ 34' - 180^\circ \\ &= 111^\circ 13' \end{aligned}$$



Example (5)



Step 3 :

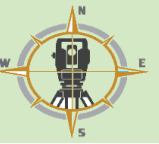


$$\theta_{E-D} = 111^{\circ} 13'$$

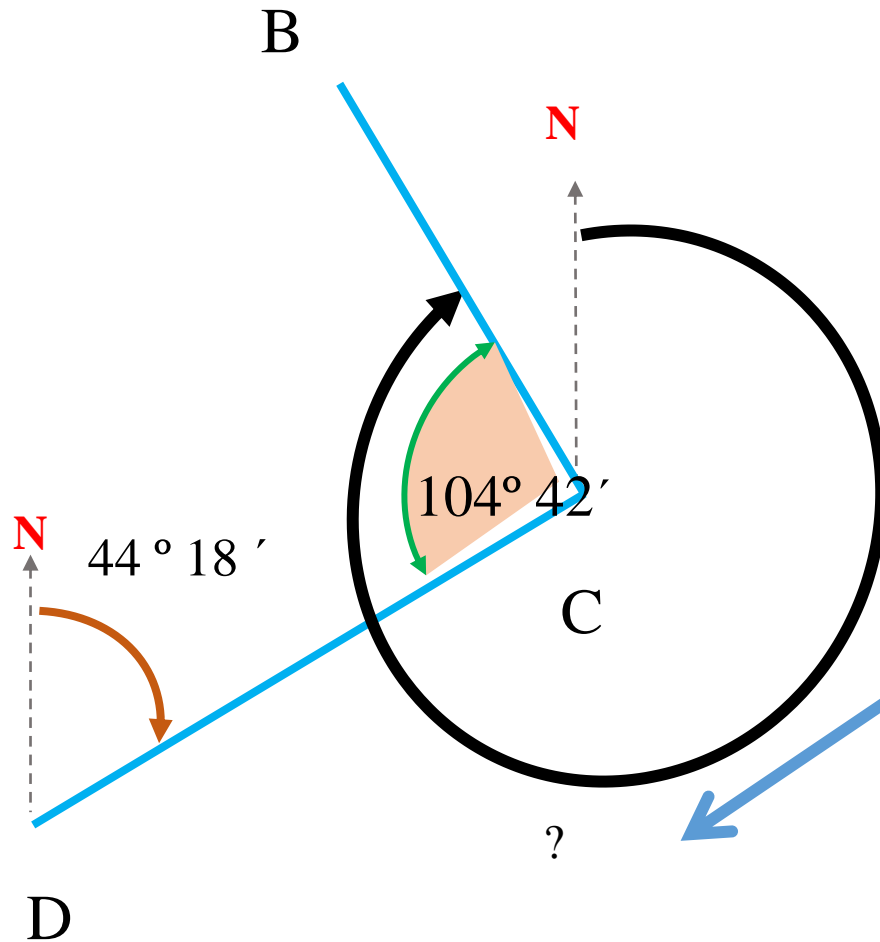
$$\begin{aligned}\text{Azimuth D-C} &= 111^{\circ} 13' + 113^{\circ} 05' - 180^{\circ} \\ &= 44^{\circ} 18'\end{aligned}$$



Example (5)



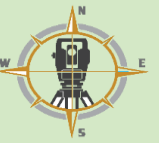
Step 4 :



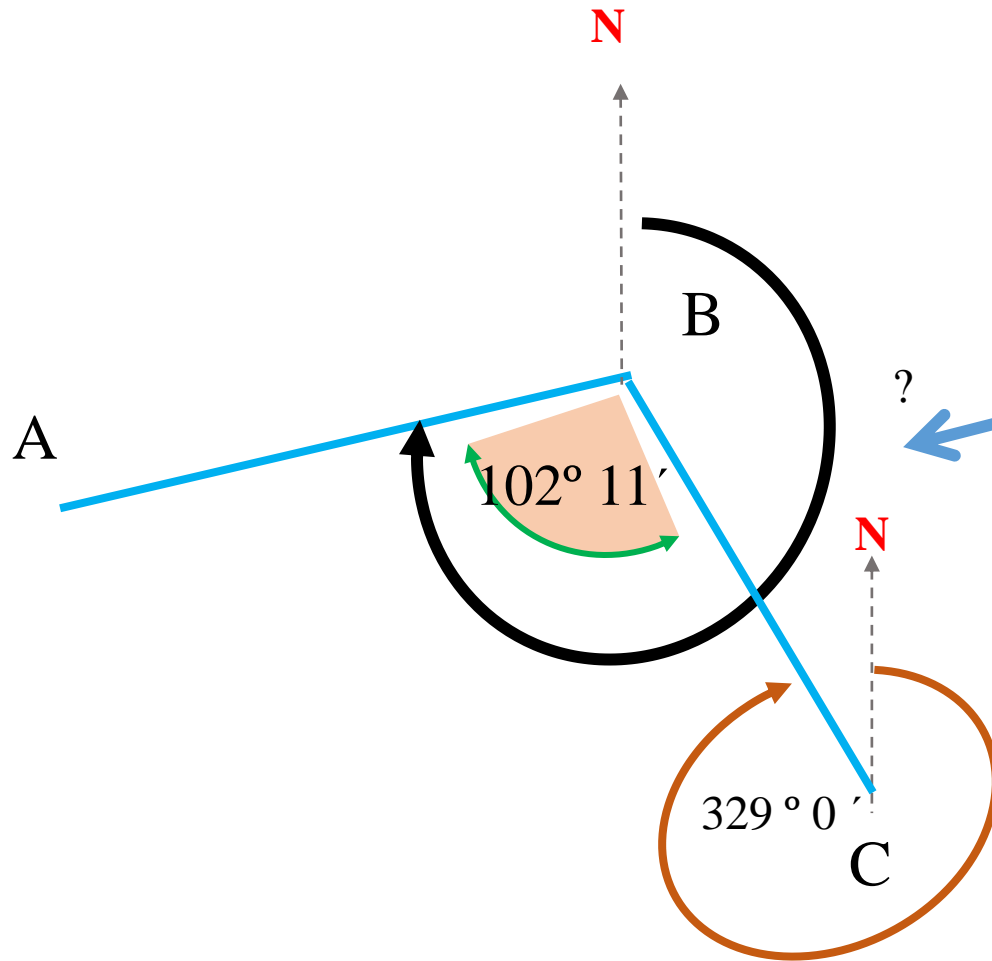
$$\theta_{D-C} = 44^{\circ} 18'$$

$$\begin{aligned}\text{Azimuth C-B} &= 44^{\circ} 18' + 104^{\circ} 42' + 180^{\circ} \\ &= 329^{\circ} 0'\end{aligned}$$

Example (5)



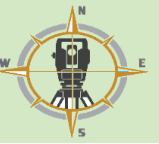
Step 5 :



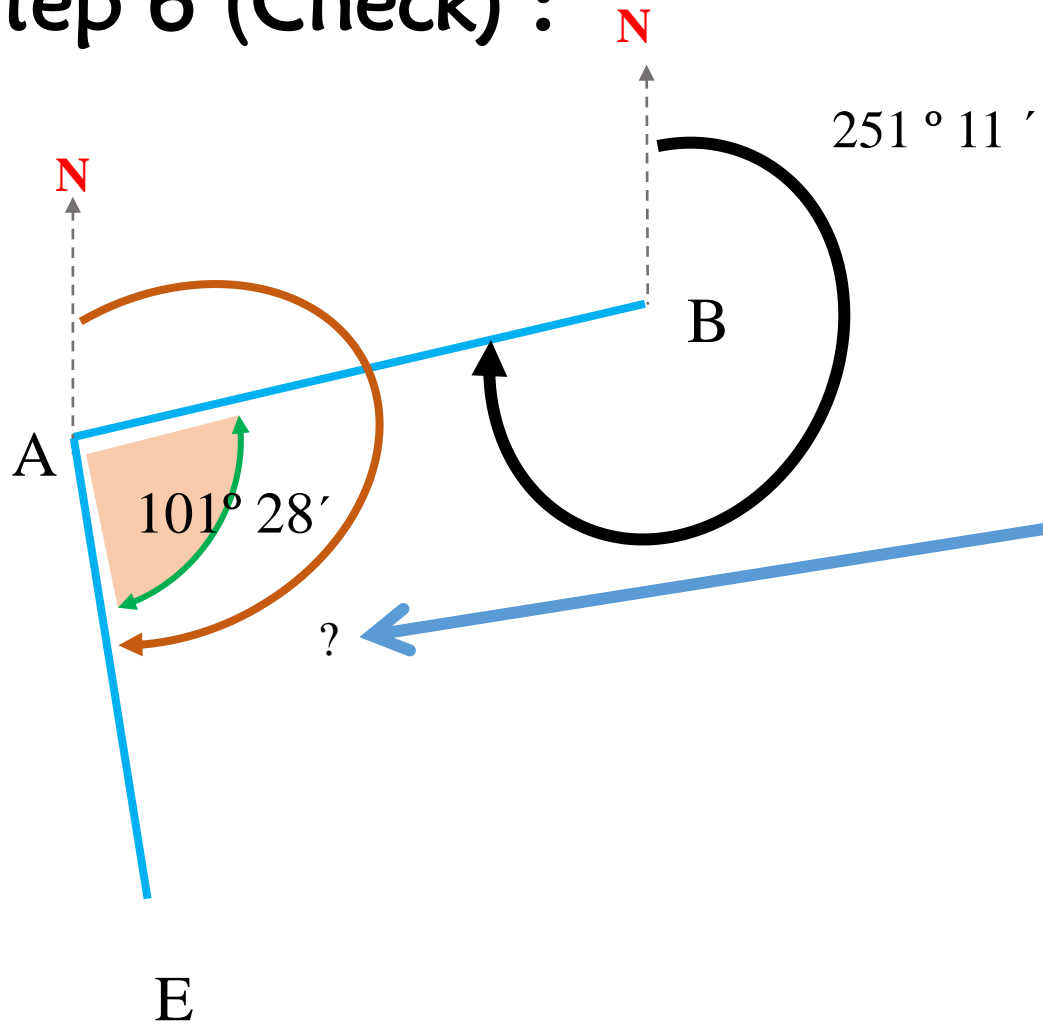
$$\theta_{C-B} = 329^{\circ} 0'$$

$$\begin{aligned} \text{Azimuth B-A} &= 329^{\circ} 0' + 102^{\circ} 11' - 180^{\circ} \\ &= 251^{\circ} 11' \end{aligned}$$

Example (5)



Step 6 (Check) :

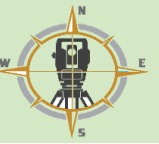


$$\theta_{B-A} = 251^{\circ} 11'$$

$$\begin{aligned} \text{Azimuth A-E} &= 251^{\circ} 11' + 101^{\circ} 28' - 180^{\circ} \\ &= 172^{\circ} 39' \end{aligned}$$



Example (5)



Azimuth A-E = $172^{\circ} 39'$

Azimuth E-A = $352^{\circ} 39'$

Azimuth E-D = $111^{\circ} 13'$

Azimuth D-E = $291^{\circ} 13'$

Azimuth D-C = $44^{\circ} 18'$

Azimuth C-D = $224^{\circ} 18'$

Azimuth C-B = $329^{\circ} 0'$

Azimuth B-C = 149°

Azimuth B-A = $251^{\circ} 11'$

Azimuth A-B = $71^{\circ} 11'$

